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Inventor: Marc Schaepkens et al.

Serial No.: 10/065,018

Filed: September 11, 2002

For: DIFFUSION BARRIER COATINGS HAVING GRADED COMPOSITIONS AND DEVICES INCORPORATING THE SAME.

GE Co. Docket No.: 125397

Group Art Unit: 1104

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Group Art Unit: 2879

MARC SCHAEPKENS et al. : Examiner: SHARLENE L. LEURIG

Serial No. 10/065,018 : Response to Paper No. 1104

Filed: September 11, 2002

For: DIFFUSION BARRIER COATINGS HAVING GRADED COMPOSITIONS AND DEVICES INCORPORATING THE SAME

BRIEF ON APPEAL

HONORABLE COMMISSIONER OF PATENTS
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellants filed a notice of appeal for the above-identified application on December 3, 2004, appealing the final rejection of claims 21-35 and 40-48. In accordance with 37 C.F.R. § 1.192, an appeal brief is set forth below and submitted in triplicate. A copy of claims 21-35 and 40-48 is annexed hereto and labeled "Appendix."

I. Real Party in Interest

The real party in interest for the above-identified patent application is the General Electric Company, the employer of the inventors named in the present invention. The named

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inventors have assigned their entire right, title, and interest in the present invention to the General Electric Company.

II. Related Appeals And Interferences

There are no known related appeals and interferences that will directly affect or be affected by or have a bearing on the Board's decision in the instant appeal.

III. Status of the Claims

Claims 21-35 and 40-49 are pending. Claim 49 has been allowed. Claims 1-20, 36-39, and 50-53 were earlier withdrawn as being directed to non-elected inventions.

IV. Status of Amendments

Appellants filed a response to Final Office Action on November 15, 2004 within two months after the date of the Final Office Action. In this response to Final Office Action, Appellants did not amend the pending claims, but presented compelling reasons for their position that claims 21-35 and 4049 are patentable. Appellants respectfully submit that the response clearly distinguishes the instant claims from the cited prior art, and clearly points out the Examiner's misunderstanding of the prior-art teachings. The Examiner issued an advisory action dated November 30, 2004 in which the Examiner continued to assert the rejection of the instant claims.

V. Summary of the Invention

In general, the present invention provides a light-emitting device that comprises a substrate and an organic electroluminescent ("EL") element disposed on the substrate. A surface of the substrate has a graded-composition barrier coating, the composition of which varies substantially continuously across the thickness of the coating. Thus, the graded-composition barrier coating is a unitary unit that has no plane across which the composition of the coating changes abruptly. Organic electroluminescent devices currently still face many challenges that have slowed their practical application. One of such challenges has been to overcome the susceptibility of these devices to chemical damage by reactive species in the environment such as oxygen and moisture. The diffusion of these species into organic EL devices tends to shorten their useful life.

A graded-composition barrier coating of the present invention is a great advance over the prior-art multilayer barrier coatings because it can be simply made without moving the coated substrate through various deposition stations for depositing various distinct layers comprising distinct materials on the substrate. In addition, a graded-composition barrier coating of the present invention also avoids the delamination of the individual layers of a prior-art multilayer barrier coating. Thus, a graded-composition barrier coating of the present invention can accelerate the practical application of these organic EL devices, and contribute in the reduction of future energy consumption by lighting devices.

VI. Issues Presented

Issue 1 – Whether claims 21-25, 40, 41, and 45-47 are novel under 35 U.S.C. § 102(e) over Graff et al. (U.S. Patent 6,522,067; hereinafter "Graff")?

Issue 2 – Whether claims 26, 42, 43, and 48 are patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo et al. (U.S. Patent 6,097,147; hereinafter "Baldo")?

Issue 3 -- Whether claims 27, 28, 32, and 33 are patentable under 35 U.S.C. § 103(a) over Graff in view of Wolk et al. (U.S. Patent 6,291,116; hereinafter "Wolk")?

Issue 4 -- Whether claims 29-31 and 44 are patentable under 35 U.S.C. § 103(a) over Graff in view of Collins, III et al. (U.S. Patent 6,642,652; hereinafter "Collins")?

Issue 5 – Whether claim 34 is patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo and Wolk?

Issue 6 – Whether claim 35 is patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo, Wolk, and Collins?

VII. Grouping of the Claims

For each ground of rejection that Appellants contest herein and that applies to more than one claim, such additional claims, to the extent separately identified and argued below, do not stand or fall together.

VIII. The Argument

Issue 1 – Whether claims 21-25, 40, 41, and 45-47 are novel under 35 U.S.C. § 102(e) over Graff?

Claims 21-25, 40, 41, and 45-47 are novel under 35 U.S.C. § 102(e) over Graff because Graff does not disclose each and every element of each of claims 21-25, 40, 41, and 45-47.

"Anticipation requires the presence in a single prior art reference disclosure each and every element of the claimed invention, arranged as in the claim." *Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.*, 221 U.S.P.Q. 481, 485 (Fed. Cir. 1984) (emphasis added). "The identical invention must be shown in as complete detail as is contained in the . . . claim." *Richardson v. Suzuki Motor Co.*, 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989) (emphasis added). "[T]he [Examiner] must identify the elements of the claims, determine their meaning in light of the specification and prosecution history, and identify corresponding elements disclosed in the allegedly anticipating reference." *Lindemann Maschinenfabrik GmbH*, 221 U.S.P.Q. at 485 (Fed. Cir. 1984).

Graff discloses a barrier stack that consists of a plurality of separate layers, at least one of which is made of an inorganic material, and at least another one of which is made of an organic polymer. See; e.g., column 1, lines 60-61, 65-66; column 2, lines 7-18, 27-33. See also Figures 1-3. Graff's entire barrier stack, not his individual separate layers of organic or inorganic material, provides the diffusion barrier to oxygen and moisture. Graff stated, at column 6, lines 63:

> "The intermediate polymer layers also decouple defects that exist in adjacent inorganic barrier layers, thus creating tortuous path for gas diffusion. . . . As can be seen from the data in Table 1, the barrier stacks used in the present invention provide exceptional environmental protection, which was previously unavailable with polymers."

Each one of Graff's barrier layer or polymer layer is made of a distinct material from the next layer, and a distinct interface separates the adjacent barrier layer and polymer layer. That Graff's layers are materially distinct and a clear demarcation exists between adjacent layers is evidenced by Graff's method of making each stack. Each layer is sequentially and subsequently formed on a previous layer. For example, Graff describes the manufacturing of his barrier stack at column 4, lines 42-54:

> "These barrier stacks can be formed by depositing a layer of polymer . . . onto a substrate or previous layer. Preferably, an acrylate-containing monomer . . . is deposited and then polymerized in situ to form the polymer layer. The acrylate-containing polymer layer is then coated with a barrier layer. Another polymer layer is deposited onto the barrier layer. U.S. Pat. Nos. 5,440,446 and 5,725,909, which are incorporated herein by reference, describe methods of depositing thin film, barrier stacks." (emphasis added.)

U.S. Patent 5,440,446, which is incorporated by reference by Graff, explicitly describes the manufacturing of Graff's multilayer barrier; for example, at column 4, lines 36-37:

> "A layer of metal 24 is deposited over at least one of the acrylate layers. A third layer of polymerized acrylate 26 is formed over the layer of metal." (emphasis added.)

Thus, Graff's barrier stack has distinct interfaces between pure polymer and pure inorganic layers, where the composition changes abruptly, as a step function, from organic to inorganic, and vice versa.

The distinct layers, each of which has a distinct composition, thus forming distinct interfaces between such layers, are further evidenced by Graff's characterization of his stack as a set of layers of polymer/barrier/polymer. Column 5, lines 6-7. Furthermore, Graff consistently uses the term "stack" to characterize his diffusion-barrier structure. A term used in a patent bear a heavy presumption that it means what it says and has the ordinary meaning that would be attributed to that word by persons skilled in the relevant art. *Texas Digital Systems, Inc. v. Telegenix, Inc.*, 308 F.3d 1193, 1201 (Fed. Cir. 2002). The ordinary meaning of a stack is an orderly pile, a large quantity of number (Webster's New Collegiate Dictionary, 1979). Thus, Graff's stack consists of a large number of orderly arranged distinct layers. Nowhere in Graff's disclosure does he mean anything other than a stack consisting of distinct layers, each of which has a uniform composition.

In contradistinction, each of claims 21-25, 40, 41, and 45-47 recites a graded-composition coating, a composition of which varies substantially continuously across its thickness. The ordinary meaning of "continuous" is "marked by uninterrupted extension in space, time, or sequence" or "having the numerical difference between the value at a point and the value at any point in a sufficiently small neighborhood of the point arbitrarily small." Webster's New Collegiate Dictionary, 1979. The continuous composition of a coating of the present invention is illustrated by a chemical analysis shown in Fig. 7. There are no distinct

planes across which the composition abruptly changes, i.e., as a step function, from organic to inorganic, and vice versa. Thus, a graded-composition barrier coating of the present invention is a unitary element, unlike a collection of separate and distinct layers in Graff's multilayer barrier.

In addition the instant specification states, for example, in paragraph 33:

> "A barrier coating of the present invention may be made by depositing reaction or recombination products of reacting species onto a substrate or film. Varying the relative supply rates or changing the identities of the reacting species results in a coating that has a graded composition across its thickness. Thus, a coating of the present invention does not have distinct interfaces at which the composition of the coating changes abruptly." (emphasis added.)

or in paragraph 34:

> "A graded composition of the coating is obtained by changing the compositions of the reactants fed into the reactor chamber during the deposition of reaction products to form the coating."

or in paragraph 42:

> "The rates of the reactant gases were varied during deposition so that the composition of the coating varied continuously across its thickness."

Thus, the coating of claims 21-25, 40, 41, and 45-47 does not consist of a stack of distinct layers separated by distinct interfaces, as disclosed in Graff.

The Applicants respectfully traverse the Examiner's assertion that Graff discloses at column 2, lines 9-12, "continuously-varying composition across its thickness, as it is formed of a mixture of two or more types of materials."

Graff states, at column 2, lines 9-12:

> "At least one of the first and second barrier layers preferably comprises a material selected from metal oxides, metal nitrides, metal carbides, metal oxynitrides, and combinations thereof."

First, this language does not automatically mean that a barrier layer always comprises two or more types of materials. Second, even if a barrier layer comprises two or more of the

listed compounds, it does not necessarily mean the composition varies continuously across its thickness because the mixture composition can be constant across the thickness. The Examiner may not read extraneous limitations into a prior art disclosure unless such extraneous limitations can be proved to be inherent. Instead, the prior-art reference must disclose either explicitly or inherently what is allegedly anticipating. And it is not inherent for a composition of a mixture to be varying continuously. The Applicants are puzzled as to how the Examiner can assert that Graff's composition of a barrier (inorganic) layer varies continuously given Graff's language.

In sum, Graff does not disclose either explicitly or inherently a coating, the composition of which varies continuously across its thickness, as is recited in claims 21-25, 40, 41, and 45-47.

Thus, Graff does not disclose each and every element of each of claims 21-25, 40, 41, and 45-47, and therefore, Graff does not anticipate these claims.

Issue 2 – Whether claims 26, 42, 43, and 48 are patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo?

Claim 26, 42, 43, and 48 are patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo because a combination of Graff and Baldo does not teach or suggest all of the limitations of each of claims 26, 42, 43, and 48.

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03, p. 2100-128 (8th ed., Rev. 2, May 2004).

As pointed out above, Graff does not teach or suggest a coating, a composition of which varies substantially continuously across its thickness, as is recited in each of claims 26, 42, 43, and 48. Adding Baldo to show a reflective metal layer still does not provide all of the elements of each of claims 26, 42, 43, and 48.

Since a combination of Graff and Baldo does not teach or suggest all of the limitations of each of claims 26, 42, 43, and 48, these claims are patentable over Graff in view of Baldo under 35 U.S.C. § 103(a).

Issue 3 -- Whether claims 27, 28, 32, and 33 are patentable under 35 U.S.C. § 103(a) over Graff in view of Wolk?

Claims 27, 28, 32, and 33 are patentable over Graff in view of Wolk because a combination of Graff and Wolk does not teach or suggest all of the limitations of each of claims 27, 28, 32, and 33.

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03, p. 2100-128 (8th ed., Rev. 2, May 2004).

As pointed out above, Graff does not teach or suggest a coating, a composition of which varies substantially continuously across its thickness, as is recited in each of claims 27, 28, 32, and 33. Adding Wolk to show an organic layer of poly(N-vinylcarbazole) still does not provide all of the elements of each of claims 27, 28, 32, and 33. Furthermore, the Applicants respectfully point out that Wolk's poly(N-vinylcarbazole) functions as a hole transporting material, which is not the same function as in the Applicants' device.

Since a combination of Graff and Wolk does not teach or suggest all of the limitations of each of claims 27, 28, 32, and 33, these claims are patentable over Graff in view of Wolk under 35 U.S.C. § 103(a).

Issue 4 -- Whether claims 29-31 and 44 are patentable under 35 U.S.C. § 103(a) over Graff in view of Collins?

Claims 29-31 and 44 are patentable under 35 U.S.C. § 103(a) over Graff in view of Collins because a combination of Graff and Collins does not teach or suggest all of the limitations of each of claims 29-31 and 44.

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03, p. 2100-128 (8th ed., Rev. 2, May 2004).

As pointed out above, Graff does not teach or suggest a coating, a composition of which varies substantially continuously across its thickness, as is recited in each of claims 29-31 and

44. Adding Collins to show that a phosphor can be used to change light color still does not provide all of the limitations of each of claims 29-31 and 44.

Since a combination of Graff and Collins does not teach or suggest all of the limitations of each of claims 29-31 and 44, these claims are patentable over Graff in view of Wolk under 35 U.S.C. § 103(a).

Issue 5 – Whether claim 34 is patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo and Wolk?

Claim 34 is patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo and Wolk because a combination of Graff, Baldo, and Wolk does not teach or suggest all of the limitations of claims 34.

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03, p. 2100-128 (8th ed., Rev. 2, May 2004).

As pointed out above, Graff does not teach or suggest a coating, a composition of which varies substantially continuously across its thickness, as is recited in claim 34. Adding Baldo to show a metal reflective layer and Wolk to show an organic layer of poly(N-vinylcarbazole) still does not provide all of the limitations of this claim.

Since a combination of Graff, Baldo, and Wolk does not teach or suggest all of the limitations of claim 34, this claim is patentable over Graff in view of Baldo and Wolk under 35 U.S.C. § 103(a).

Issue 6 – Whether claim 35 is patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo, Wolk, and Collins?

Claim 35 is patentable under 35 U.S.C. § 103(a) over Graff in view of Baldo, Wolk, and Collins because a combination of Graff, Baldo, Wolk, and Collins does not teach or suggest all of the limitations of claim 35.

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03, p. 2100-128 (8th ed., Rev. 2, May 2004).

As pointed out above, Graff does not teach or suggest a coating, a composition of which varies substantially continuously across its thickness, as is recited in claim 35. Adding Baldo to show a metal reflective layer, Wolk to show an organic layer of poly(N-vinylcarbazole), and Collins to show a phosphor still does not provide all of the elements of this claim.

Since a combination of Graff, Baldo, Wolk, and Collins does not teach or suggest all of the limitations of claim 35, this claim is patentable over Graff in view of Baldo, Wolk, and Collins under 35 U.S.C. § 103(a).

IX. Conclusion

For the reasons set forth above, Appellants respectfully submit that claims 21-35 and 40-48 are patentable and should be allowed. Appellants respectfully request that the Honorable Board of Patent Appeals and Interferences reverse the Examiner's final rejection and hold claims 21-35 and 40-48 allowable.

Respectfully submitted,

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Schenectady, New York
December 16, 2004

APPENDIX

The Claims on Appeal

21. A light-emitting device comprising:

a flexible substantially transparent substrate having a first substrate surface and a second substrate surface, at least one of said substrate surface being coated with a graded-composition barrier coating, a composition of which varies substantially continuously across a thickness thereof; and

an organic electroluminescent ("EL") member which comprises an organic EL layer disposed between two electrodes and is disposed on said flexible substantially transparent substrate.

22. The light-emitting device according to claim 21 further comprising a substantially transparent film having a second graded-composition barrier coating disposed thereon, said substantially transparent film being disposed on said organic EL member opposite to said flexible transparent substrate.

23. The light-emitting device according to claim 21, wherein said flexible substantially transparent substrate comprises a polymeric material selected from the group consisting of polyethyleneterephthalate, polyacrylates, polycarbonate, silicone, epoxy resins, silicone-functionalized epoxy resins, polyester, polyimide, polyetherimide, polyethersulfone, polyethyelenenapthalene, polynorbonene, and poly(cyclic olefins).

24. The light-emitting device according to claim 21, wherein said coating material is selected from the group consisting of organic, inorganic, ceramic materials, and combinations thereof.

25. The light-emitting device according to claim 24, wherein said inorganic and ceramic materials are selected from the group consisting of oxide, nitride, carbide, boride, and combinations thereof of elements of Groups IIA, IIIA, IVA, VA, VIA, VIIA, IB, and IIB, metals of Groups IIIB, IVB, and VB, and rare-earth metals.

26. The light-emitting device according to claim 21 further comprising a reflective layer disposed on said organic EL layer, said reflective layer comprising a material selected from the group consisting of metals, metal oxides, metal nitrides, metal carbides, metal oxynitrides, metal oxycarbides, and combinations thereof.

27. The light-emitting device according to claim 21, wherein said organic EL layer comprises a material selected from the group consisting of poly(n-vinylcarbazole), poly(alkylfluorene), poly(paraphenylene), polysilanes, derivatives thereof, mixtures thereof, and copolymers thereof.

28. The light-emitting device according to claim 21, wherein said organic EL layer comprises a material selected from the group consisting of 1,2,3-tris{n-(4-diphenylaminophenyl) phenylamino} benzene, phenylanthracene, tetraarylethene, coumarin, rubrene, tetraphenylbutadiene, anthracene, perylene, coronene, aluminum-(picolymethylketone)-bis{2,6-di(t-butyl)phenoxides}, scandium-(4-methoxy-picolymethylketone)-bis(acetylacetonate), aluminum-acetylacetonate, gallium-acetylacetonate, and indium-acetylacetonate.

29. The light-emitting device according to claim 21 further comprising a light-scattering layer, said layer comprising scattering particles dispersed in a substantially transparent matrix and being disposed on a surface of said substrate opposite to said organic EL member.

30. The light-emitting device according to claim 29 further comprising particles of a photoluminescent ("PL") material mixed with scattering particles in said light-scattering layer, wherein said PL material is selected from the group consisting of $(Y_{1-x}Ce_x)_3Al_5O_{12}$; $(Y_{1-x-y}Gd_xCe_y)_3Al_5O_{12}$; $(Y_{1-x}Ce_x)_3(Al_{1-y}Ga_y)O_{12}$; $(Y_{1-x-y}Gd_xCe_y)(Al_{5-z}Ga_z)O_{12}$; $(Gd_{1-x}Ce_x)Sc_2Al_3O_{12}$; $Ca_8Mg(SiO_4)_4Cl_2:Eu^{2+},Mn^{2+}$; $GdBO_3:Ce^{3+}$, Tb^{3+}; $CeMgAl_{11}O_{19}:Tb^{3+}$; $Y_2SiO_5:Ce^{3+},Tb^{3+}$; $BaMg_2Al_{16}O_{27}:Eu^{2+},Mn^{2+}$; $Y_2O_3:Bi^{3+},Eu^{3+}$; $Sr_2P_2O_7:Eu^{2+},Mn^{2+}$; $SrMgP_2O_7:Eu^{2+},Mn^{2+}$; $(Y,Gd)(V,B)O_4:Eu^{3+}$; $3.5MgO.0.5MgF_2.GeO_2:Mn^{4+}$ (magnesium fluorogermanate); $BaMg_2Al_{16}O_{27}:Eu^{2+}$; $Sr_5(PO_4)_{10}Cl_2:Eu^{2+}$; $(Ca,Ba,Sr)(Al,Ga)_2S_4:Eu^{2+}$; $(Ba,Ca,Sr)_5(PO_4)_{10}(Cl,F)_2:Eu^{2+},Mn^{2+}$; $Lu_3Al_5O_{12}:Ce^{3+}$; $Tb_3Al_5O_{12}:Ce^{3+}$; and mixtures thereof; wherein $0 \le x \le 1$, $0 \le y \le 1$, $0 \le z \le 5$ and $x+y \le 1$.

31. The light-emitting device according to claim 29 further comprising at least an organic PL material dispersed in said scattering layer, said organic PL material being capable of absorbing at least a portion of electromagnetic ("EM") radiation emitted by said organic EL material and emitting EM radiation in a visible spectrum.

32. The light-emitting device according to claim 21, wherein said organic EL member further comprises at least an additional layer disposed between one of said electrodes and said organic EL layer, said additional layer performing at least a function selected from the group consisting of electron injection enhancement, electron transport enhancement, hole injection enhancement, and hole transport enhancement.

33. A light-emitting device comprising:

a flexible substantially transparent substrate having a first substrate surface and a second substrate surface, at least one of said substrate surface being coated with a graded-composition barrier coating, a composition of which varies substantially continuously across a thickness thereof; and

an organic electroluminescent ("EL") member which comprises an organic EL layer disposed between two electrodes and is disposed on said flexible substantially transparent substrate;

wherein said flexible substantially transparent substrate comprises a polymeric material selected from the group consisting of polyethyleneterephthalate, polyacrylates, polycarbonate, silicone, epoxy resins, silicone-functionalized epoxy resins, polyester, polyimide, polyetherimide, polyethersulfone, polyethylenenapthalene, polynorbonene, and poly(cyclic olefins); said coating material is selected from the group consisting of organic, inorganic, ceramic materials, and combinations thereof; and said organic EL layer comprises a material selected from the group consisting of poly(n-vinylcarbazole), poly(alkylfluorene), poly(paraphenylene), polysilanes, derivatives thereof, mixtures thereof, copolymers thereof, 1,2,3-tris{n-(4-diphenylaminophenyl) phenylamino} benzene, phenylanthracene, tetraarylethene, coumarin, rubrene, tetraphenylbutadiene, anthracene, perylene, coronene, aluminum-(picolymethylketone)-bis{2,6-di(t-butyl)phenoxides}, scandium-(4-methoxy-picolymethylketone)-bis(acetylacetonate), aluminum-acetylacetonate, gallium-acetylacetonate, and indium-acetylacetonate.

34. A light-emitting device comprising:

a flexible substantially transparent substrate having a first substrate surface and a second substrate surface, at least one of said substrate surface being coated with a first

graded-composition barrier coating, a composition of which varies substantially continuously across a thickness thereof;

an organic electroluminescent ("EL") member which comprises an organic EL layer disposed between two electrodes and is disposed on said flexible substantially transparent substrate;

a reflective layer disposed on said organic EL member opposite to said substrate; and

a substantially transparent film having second graded-composition barrier coating disposed on said reflective layer opposite to said organic EL member;

wherein said flexible substantially transparent substrate and said substantially transparent film comprise a polymeric material selected from the group consisting of polyethyleneterephthalate, polyacrylates, polycarbonate, silicone, epoxy resins, silicone-functionalized epoxy resins, polyester, polyimide, polyetherimide, polyethersulfone, polyethylenenapthalene, polynorbonene, and poly(cyclic olefins); said first and second graded-composition barrier coating material comprise a material independently selected from the group consisting of organic, inorganic, ceramic materials, and combinations thereof; and said organic EL layer comprises a material selected from the group consisting of poly(n-vinylcarbazole), poly(alkylfluorene), poly(paraphenylene), polysilanes, derivatives thereof, mixtures thereof, copolymers thereof, 1,2,3-tris{n-(4-diphenylaminophenyl) phenylamino} benzene, phenylanthracene, tetraarylethene, coumarin, rubrene, tetraphenylbutadiene, anthracene, perylene, coronene, aluminum-(picolymethylketone)-bis{2,6-di(t-butyl)phenoxides}, scandium-(4-methoxy-picolymethylketone)-bis(acetylacetonate), aluminum-acetylacetonate, gallium-acetylacetonate, and indium-acetylacetonate.

35. The light-emitting device according to claim 34 further comprising a scattering layer disposed on said substantially transparent substrate opposite to said organic EL member, said scattering layer comprising scattering particles and particles of a PL material dispersed in a substantially transparent matrix.

40. A method for making a light-emitting device, said method comprising:

providing a flexible substantially transparent substrate having a first substrate surface and a second substrate surface, at least one of said substrate surface being coated with a first graded-composition barrier coating, a composition of which varies substantially continuously across a thickness thereof; and

disposing an organic EL member which comprises an organic EL layer disposed between two electrodes on said flexible substantially flexible substrate.

41. The method for making a light-emitting device according to claim 40, wherein said disposing said organic EL member comprises forming a first electrode by depositing a first electrically conducting material on said graded-composition barrier coating; depositing said organic EL layer on said first electrode; and forming a second electrode by depositing a second electrically conducting material on said organic EL layer.

42. The method for making a light-emitting device according to claim 40 further comprising disposing a reflective layer on said organic EL member opposite to said substantially transparent substrate.

43. The method for making a light-emitting device according to claim 42 further comprising disposing a substantially transparent film that is coated with a second graded-composition barrier coating on said reflective layer.

44. The method for making a light-emitting device according to claim 40 further comprising disposing a scattering layer on a surface of said substrate, said EM-radiation conversion layer comprising particles of a PL material dispersed in a substantially transparent matrix.

45. The method for making a light-emitting device according to claim 40, further comprising disposing a second graded-barrier coating on said organic EL member opposite to said substantially transparent substrate.

46. The method for making a light-emitting device according to claim 40, further comprising disposing a second flexible substrate on said organic EL member, said second substrate having a second graded-composition barrier coating thereon.

47. A method for making a light-emitting device, said method comprising:

providing a flexible substantially transparent substrate having a first substrate surface and a second substrate surface;

depositing a first graded-composition barrier coating on at least one of said substrate surface, a composition of said first barrier coating varying substantially continuously across a thickness thereof, said depositing being carried out by a method selected from the group consisting of plasma-enhanced chemical-vapor deposition, radio-frequency plasma-enhanced chemical-vapor deposition, expanding thermal-plasma chemical-vapor deposition, sputtering, reactive sputtering, electron-cyclotron-resonance plasma-enhanced chemical-vapor deposition, and inductively-coupled plasma-enhanced chemical-vapor deposition;

disposing an organic EL member which comprises an organic EL layer disposed between two electrodes on said flexible substantially flexible substrate; and

disposing a substantially transparent film that is coated with a second graded-composition barrier coating on said organic EL member, said second graded-composition barrier coating having a composition that varies substantially continuously across a thickness thereof and being deposited on said film by a method selected from the group consisting of plasma-enhanced chemical-vapor deposition, radio-frequency plasma-enhanced chemical-vapor deposition, expanding thermal-plasma chemical-vapor deposition, sputtering, reactive sputtering, electron-cyclotron-resonance plasma-enhanced chemical-vapor deposition, inductively-coupled plasma-enhanced chemical-vapor deposition, and combinations thereof.

48. The method for making a light-emitting device according to claim 47 further comprising disposing a reflective layer between said organic EL member and said coated substantially transparent film.